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THESIS

SEANET REMOTE WIRELESS INTERNET PROJECT MANAGEMENT PLAN

by

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Ubiquitous computing, the ability to use computer resources anywhere and at anytime to accomplish tasks, is a capability that is in much demand. The Internet has provided an opportunity to meet this demand. However, access to the Internet is limited by connections to land-based wired systems. In order to truly achieve effective ubiquitous computing, technology must be developed that extends Internet access to remote and mobile platforms by using wireless access. The SEANET is a proof of concept collaborative project seeking to extend Internet access to the sea for the Oceanographic Research Fleet. This thesis studies how the Internet evolved to draw lessons learned that can be applied to the development of SEANET. It also presents a possible method for more effectively meeting the SEANET goals through use of a Project Management Plan.

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SEANET REMOTE WIRELESS INTERNET PROJECT MANAGEMENT PLAN

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ABSTRACT

Ubiquitous computing, the ability to use computer resources anywhere and at anytime to accomplish tasks, is a capability that is in much demand. The Internet has provided an opportunity to meet this demand. However, access to the Internet is limited by connections to land-based wired systems. In order to truly achieve effective ubiquitous computing, technology must be developed that extends Internet access to remote and mobile platforms by using wireless access. The SEANET is a proof of concept collaborative project seeking to extend Internet access to the sea for the Oceanographic Research Fleet. This thesis studies how the Internet evolved to draw lessons learned that can be applied to the development of SEANET. It also presents a possible method for more effectively meeting the SEANET goals through use of a Project Management Plan.

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I. INTRODUCTION

A. PURPOSE OF THE THESIS

The Internet has seen exponential growth since 1995 when the Internet became commercialized (Rutkowski, 1997). This commercialization has brought about opportunities for enhanced capabilities influencing many activities by the ability to access information. The World Wide Web (WWW), an application of the Internet, created a way to use hyperlinks to visually tap the Internet technology. The WWW allowed computer lay people to understand how the Internet could benefit them in everyday life through its intuitive use of icons. "The WWW created a social turning point for networking equivalent to the transition seen in the automobile industry when the Model-T automobile was produced." (Buddenberg, 1997) The Internet was no longer in the realm of the technically inclined and computer savvy. Greater usage of the Internet has resulted in business being able to tap untold markets, increase revenues, and increase profits. Greater usage has also resulted in lower unit costs for access. Reduced costs of operating networks benefits the owners of the networks by making it cheaper for them to operate and by affording them greater resources to invest in enhancements and upgrades to meet and exceed user expectations.

Commercialization of the Internet did not occur until 26 years after the ARPANET, the precursor of the Internet, was launched as marked by the first four hosts of the network working. Many people and organizations that are users of the Internet today did not have expectations until the last two years of how they would benefit from access to the Internet. Users expectations have grown well after the base technology matured. Most users did not have expectation nor quite frankly could anyone predict how quickly the growth of the Internet occurred. But, this growth in usage is predominantly limited to those users with access to land based Internet connectivity either through the telephone system or through the terrestrial mobile cellular system. There are many potential users that either operate in remote areas without access to this land based Internet connectivity or that want the flexibility that a space or air wave based wireless infrastructure would provide. A similar expansion in usage of space and air wave based media like the expansion of the land based media is imminent (Kappel, 1997). Potential users are beginning to demand access to the same capabilities that the land based infrastructure supports. Users have expectations of using new technology immediately after that new technological idea is conceived and well before the technology is mature.

One of these of users is the Oceanographic Research Fleet. They want the capability to access WWW resources through the Internet while afloat to assist, speed, integrate, and coordinate their research (Kappel, 1997). This not for profit

organization is acting as a proof of concept test bed for the SEANET project. This SEANET project is a collaborative effort designed to foster remote wireless connectivity toward the end of meeting the Oceanographic Research Fleets demands. They represent any number of groups or individual users that, once concepts are proven and infrastructure is established, would benefit from Internet access at remote and/or mobile sites not supported by the present land based system. This author will examine how the SEANET project can achieve its goals of expanding service more effectively thereby meeting users expectations.

B. SCOPE

The scope of this thesis will include: (1) a review of how the land based Internet expanded, (2) a description of the SEANET project as representative of any user in remote areas not supported by wired Internet access, (3) identification of the communications resources, infrastructure, and technology needed to provide remote wireless Internet access, and (4) a recommended plan for more effectively expanding availability of remote access to users demanding access.

C. METHODOLOGY

This research will entail conducting a review of the ARPANET to Internet expansion to gather lessons learned that can be applied to the SEANET project. This research will the provide an overview of the system that SEANET represents

that provide remote access and identify emerging capabilities that SEANET can leverage to more quickly support their users. This research will describe techniques for more effectively expanding remote Internet access that will benefit the SEANET project. Finally, this research will propose a project management plan to provide the controls necessary to ensure the SEANET project meets it objectives on time.

II. REVIEW OF THE ARPANET TO INTERNET EXPANSION

A. INTRODUCTION OF THE INTERNET EVOLUTION

In order to understand how a space or air-wave based (wireless) Internet can evolve, it is useful to examine the evolution of the terrestrial Internet. This will provide an appreciation of the strategies used to develop the terrestrial Internet and provide lessons learned from that process. If applicable, these strategies and lessons learned will better allow the SEANET project to meet its goals. By tailoring strategies and lessons learned from the evolution of the ARPANET to Internet, the SEANET project should be able to effectively implements its solutions, meet its user's requirements, and extend the life cycle of the project. This will provide a baseline from which to compare the SEANET project development proposal.

This chapter will describe the strategies used to evolve from ARPANET to Internet. This chapter will review how the Internet progressed. Finally, this chapter will list lessons learned that may prove useful to the SEANET project.

B. STRATEGIC APPROACHES OF THE EXPANSION

1. Introduction

This section will describe the strategic approaches used to evolve from ARPANET to Internet. Research into the evolution of the Internet provides three

(3) strategic approaches that resulted in the evolution of the Internet. These approaches involve the descriptions of the spirit, the standards, and the organization and management style that represent how the Internet evolved.

2. The Spirit of the Internet Evolution

The spirit of the evolution was one of pure research initially (Hauben, 1995). The researchers had an abstract task to develop a manner to conduct command and control in the event of a nuclear attack. The researchers felt the best way to achieve this task was with a collaborative spirit. They sought open participation of any group, person, or idea that would benefit this community of researchers having the common interest of connecting computers together. The researchers were not interested in only developing a military product. This attitude and approach seems odd for a group that is ultimately solving a purpose for the military but fits with the time period of the projects beginnings — the mid to late 1960s.

3. The Standards of the Internet Evolution

The standards maintained and demanded of the researchers by themselves was critical to the evolution of the Internet. The expectation was that in order to make this work at a grand level that "the best academic computer centers" (ARPA draft III-7) must be used. The concept of a "Grand Design" is one of a comprehensive design that accounts for almost all possible foreseen uses of the technology

being developed or the infrastructure being built. Using the best academic centers served two purposes: (1) to get the best people and resources working on the problem, and (2) ensure development of interactive computer technology occurred at a level that was not merely commercially expedient.

4. The Organization and Management Style of the Internet

There must be an organizational structure and management style that is focused on high level goals. An organization that promotes the project development process but is not just immediately concerned with the process yielding an instantaneously profitable solution. ARPA, the precursor of the DAPRA, charter tends toward the research end of research and development focusing on functions as opposed to specific products (Buddenberg, 1997). This constitutes a goal oriented process versus a product oriented process. The management style must be supportive not directive yet ensure that there is enough cohesion to integrate and trigger system planning events after each advance and breakthrough. This style is appropriate when not constrained by time nor resources. Time nor resources appeared to have been a problem in the late 1960s.

C. PHASES OF THE INTERNET DEVELOPMENT

1. Introduction

This section will give a description of the phases of the evolution of the Internet from its origins as the in the ARPA. The Air Force commissioned Paul

Baran of the Rand Corporation to study how to command and control strategic nuclear forces after a nuclear explosion (Tappendorf, 1995). Baran determined that a packet switched network with no central command center or hub would best accomplish this task (Tappendorf, 1995). This lead to network research in how to achieve this concept. This research initially was done under the auspices of ARPA. The ARPANET phase was followed by the National Science Foundation assuming responsibility for the Internet to achieve greater usage of the technology for purposes other than military research, command and control. The final phase is our present Internet commercial phase. This section will describe what happened to provide the basis for SEANET research and development in non-terrestrial networks. It will also discuss what went well and not so well during this period.

2. The ARPANET Phase

a. What Happened in this Phase

This phase deals with the period from Baran's research in 1966 to 1984 when NSF became responsible for the present day Internet. This phase is marked by the era of large mainframe computer operated by technically savvy programmers for the benefit of the government, universities, and large companies that could afford to operate mainframe.

(1) **Research.** In 1964 the director of DARPA testified before Congress that the next steps in computing would be to link individuals

through computers. (Norberg, 1955) This led to the push to link computers via a network under the auspices of DARPA's Information Processing Techniques Office (IPTO). This resulted in Requests for Proposals (RFP) in networking from DARPA in July 1968 (Kulikowski, 1994). Professors and students at UCLA "proposed to DARPA to organize and run a Network Measurement Center for the ARPANET project" (Cerf, 1993). Research continued at UCLA in the area of observing behavior of a networks until September 1969. 2 September 1969 was when four Interface Message Processors (IMP-1) computers at UCLA, SRI, UCSB, and University of Utah were linked by a circuit to allow for actual study of network behavior.

(2) **Engineering.** The immediate operation of this four node network proved that the packet-switched concept of Paul Baran would work. The next step was to get that concept to work on many dissimilar types of computers. Steve Crocker, a graduate student at UCLA, led the design of protocols for host computers to operate on the APRANET (Tappendorf, 1995).

(3) **Infrastructure.** Progress in developing and expanding the ARPANET infrastructure occurred slowly. There were many different platforms that needed the hardware and software that would use protocols to connect the different architectures to the ARPANET (Cerf, 1993). This protocol was the Network Control Protocol (NCP) in 1971. There was still little incentive

to develop the infrastructure quickly. This incentive appeared in the form of an opportunity to demonstrate how the ARPANET worked at the International Conference on Computing Communication in 1972. The demonstration showed how ARPANET could run applications all over the U.S. The success of the demonstration led to the establishment of the International Network Working Group (INWG) organized and chaired by Vinton Cerf (Cerf, 1993) to further develop the infrastructure. It began to look for other ways to transmit data. It launched two projects: (1) satellite transmission of data that became an operational network named SATNET in 1976 and (2) a packet switched radio network (Tappendorf, 1995). These two projects made NCP unable to meet the networks needs. Cerf got placed in charge of the whole Internet after being hired by IPTO to further develop the Internet and design protocols for packet radio, satellite, and terrestrial Internet. In 1973, Cerf's group developed Transmission Control Protocol/Internet Protocol (TCP/IP). Internet Protocols become operational in 1978 (Cerf, 1993). DOD began experimenting with its use and later required it for ARPANET. The protocols, that would later result in the network later being called the Internet, were born 1 January 1983 when NCP was deactivated and TCP/IP became the protocol on APRANET. In 1984, USD(R&E) chose ARPANET technology over Autodin II for the Defense Data Network.

(4) **Applications.** A critical portion of this section are the applications that breathed life into the technology. The services that proved essential prior to the ARPANET demonstration in September 1972 include the first email program by Larry Roberts in 1969, dial-up services for remote terminals developed called TELNET in 1972, and file transfer protocols (FTP). Other developments that enhanced the Internet's developments include BITNET in 1981, a store and forward network; CSNET in 1981, a peer exchange mail service; and in 1983 the development of the Domain Name Server (DNS) that allowed message to ask for directions to its destination thus easing administration of machines and use by participants of the network. DNS pairs names with numbered IP addresses to assist in routing.

(5) **Scaling Issues.** The original design of the network address space only considered the need for 256 networks. Based on those times, this seemed more than adequate. To handle many local area networks and the limitations of the address space, INWG developed the concept of Class A, B, and C networks as a means of partitioning the 32-bit address space (Cerf, 1993). Today the address space is becoming overwhelmed but IPv6, the next generation IP should solve the explosive need for network Ids.

b. What Went Well and Not Well In This Phase

There are three things that went well during this phase. They were the pursuit of basic research, the establishment of a grass roots community in the field of network computing, and the consolidation of the techniques to move from a mainframe world of computing to a distributed form of computing. Basic research spawned the development and experimentation with different ways to communicate. The relationships developed among the early pioneers of networks computing has altered the world through the systems they developed, the companies they formed, and the community they fostered. This is also a period of consolidation of techniques to handle the ability for computers to communicate or transmit data from a large set of architectures, hardware and software techniques to a protocol that is still in use today: TCP/IP. The two big payoffs were: (1) TCP and IP, as state and stateless machines respectively, laid the foundation for scaling and (2) TCP/IP (in the large) is operating system agnostic since these protocols have been implemented on dozens of operating systems. The one thing that did not go well during this period was implementation of scaling. The original pioneers did not comprehend that there would ever be a need for more than 256 networks back in 1973 since there were so few networks and since no one could fathom the impact that networking would have on the world. However, it is important for any future development in that the designer must think not only

about how to meet the requirement but also how the design might be used for purposes not intended or stated in the original requirement. The domain name server concept was key to mitigating this scaling problem that is a opportunity for network designer of the future.

DNS went through at least a couple of stages of evolution significant to the scaling issue. The first approach was to have a host file in each end system. The IP-name pairing is a list in a file on each end system kept its own list. Every time a new host was added every end system updated their host files. The second approach was the use of a centralized host file at the NIC. New host were added to the NIC's host file. Periodically, the host file was FTPed to end systems. Centralization caused the updates to always be behind and the overhead that resulted, although better than manual updates, was rapidly overtaken by network growth. The third stage was the invention of DNS done by Paul Mockapetris that is a classical decentralized database (Buddenberg, 1997).

3. The ARPANET to NSFNET Phase

The next phase is considered the transition from the ARPANET to the NSFNET phase. The NSFNET phase can be considered a time for expanded usage. Rather than just use the network for command and control usage, researchers of any variety would purchase time to use the super computer centers. This move added credibility to the net since the entire research community began

using the network. It was not just the Defense Department nor just the computer science community that saw the advantages of having a new way to communicate. Upgrades to the backbone occurred to meet the growing needs of the overall community. Higher speed networking and easier access led to more users. These users were now able to do more things because of the ability to transfer greater amounts of data. This section will describe how the research, engineering, infrastructure, and general activities developed during the period of 1984 to 1995.

a. *What Happened In This Phase*

(1) **Research.** This period represents stability and broad based growth of the Internet within the research community. NSF decided to become involved in networking with the establishment of five super computer research centers connected to each other by a backbone that was linked to the ARPANET (Tappendorf, 1995). Researchers could purchase time on this network. This NSFNET became very popular and resulted in network traffic exceeding the capability of the NSF backbone and ARPANET. The backbone needed upgrades that NSF itself was not interested in managing. In 1985, NSF deployed its upgraded backbone to a T1 connection that Merit Corp., MCI, IBM, and U. of Michigan (U of M) developed (Kulikowski, 1994). By October 1985 most ARPANET users were shunted to the NSFNET's T1 connection with the ARPANET's 56Kbps connection being decommissioned in 1990. Merit, IBM,

MCI, and U of M later formed a non-profit firm called Advanced Network Systems (ANS) that did high speed networking research. In 1987, Computer Engineering Research Network (CERN) was created from the merger of BITNET and CSNET. There research later developed the World Wide Web technology that transformed the Internet.

(2) **Engineering.** During the period that the NSF influenced the Internet's development there really were not many changes to the physical network. NSF, however, did encourage the wide spread use of the Internet in the non-commercial, academic, and government research communities. The credibility and funding that NSF provided to the Internet fostered growth beyond expectations. Every time the NSF increased the size of the backbone, traffic on the network increased to fill the capacity.

(3) **Infrastructure.** NSF's involvement was critical to the improvements in infrastructure. This proved expensive. At first, NSF sought to connect researchers directly to one of the five super computer centers. The demand for service made the cost of running these connections prohibitive. Therefore, NSF began to fund connections to research centers already connected the NSFNET rather than directly to one of the five super computers. The final improvement in infrastructure to NSFNET occurred in 1991 when NSF connected all sites via a T3 connection developed from the research of ANS. The network

continued to grow immensely. Accordingly in 1991, NSF created a new network called the National Research and Education Network (NREN) to be a non-commercial network for high speed networking research. The network was becoming unmanageable from NSF's view.

(4) **Applications.** The key application developed during this phase is the WWW technology. The technology provided the ability to connect documents to other forms of media in the form of a global information database. It provided a way for Internet users to use graphics and hypertext. This allowed non-technical users to visualize and search for information in a very intuitive ways. This further increased usage of the Internet and forced NSF to reconsider its role in the Internet.

(5) **Scaling Issues.** NSF realized their network was operating differently. Therefore, they announced they would no longer allow direct access to the backbone. Instead access would be purchased from a contractor representing NSF. NSF gives the following reasons for this: (1) the government does not want to be in the communications business and (2) this allows for commercialization of the net as the government restricts commercial use. The result is the commercial Internet is born.

b. What Went Well and Not Well In This Phase

NSF realized the net was working differently and not along the established purposes of this governmental foundation. This revelation marks the end of this phase and the beginning of the transition to the commercial Internet. 1988 to 1993 was a period of major growth from the order of magnitude of thousands of users to millions of users (Rutkowski, 1997). The research and commercial aspects of the network began leaping ahead of the military sector with NSF upgrading to T1 and T3 connections while DOD was still using 56kbps connections (Buddenberg, 1997).

4. The Internet Phase

The Internet Phase began with the NSF contracting with access providers in order to get government out of the communications business and to allow commercialization of the net. This last phases of placing the Internet in the commercial sector provides the basis for the free-wheeling nature of the Internet today. It directly placed the marketing of products and services based on market forces that exploit Internet technology in the private sector after the infrastructure of building the Internet had been established.

a. What Happened In This Phase

(1) **Research**. This phase is still evolving. The research that occurs is in the areas of high speed networking, modifying the address space

to deal with the ever increasing market demand for network identification address and user identification address, and how to standardize and consolidate the best platforms, protocols and channels for efficient use of Internet resources. The concept of ubiquitous computing is for people to communicate, collaborate, work and play no matter what platform they use nor whether they are on land, at sea, or in space above the earth. The SEANET project is an example of the type of research being conducted to achieve the integration and expansion of Internet access across the globe.

(2) **Engineering.** Before solutions to evolve the Internet into a ubiquitous communications medium can occur, consensus must develop between the ever increasing number of community of users or stakeholders with an interest in the Internet. The Internet is not just a network for the use of the technologically savvy. The many stakeholders include governmental bodies across the globe, international and multi-national corporations including broadcast television, telecommunications, and satellite providers, the academic and research communities, and private citizens from every walk of life. These varied stakeholder's desires all must be negotiated prior to designing, building and implementing any adjustments or major enhancements to the Internet. Therefore, solutions are falling into the realm of the world political structure because all stakeholders realize that far too much money and far too much power can be

shifted by the use and abuse of the Internet. Consensus must be achieved before a solution arrives. This impacts the infrastructure.

(3) **Infrastructure.** The infrastructure that supports the Internet is undergoing consolidation and integration in order to take advantage of economies of scale. Basic economics and market forces are causing different stakeholders to follow different strategies to compete in providing what customers want and meeting demand. Examples of this include the merger of MCI (one of the first providers of Internet access) and British Telecommunications (BT). In 1993, when the NSF subsidies ended, all the non-profit ISPs either reinvented themselves as for-profit, taxpaying entities or they got bought up by for-profit corporations. None of the formerly non-profit ISPs folded. The significance is that the non-commercial acceptable use policy went away and the five-year NSF subsidy period turned a neat military R&D program into an industry. Partnerships are developing to generate the skills and capital to invest in the large dollar game of evolving the Internet to the world's needs not just any one isolated group of individuals needs. This business process of adjusting the structure to meet the visualized end state is occurring right now. How this plays out is yet to be determined. Market forces have proven the most efficient way to achieve the highest quality products and services at the most economical prices as long as

there is competition. This author believes that this will continue to be the case. This might alter the products and services currently available.

(4) **Applications.** The following is a list of the major applications and services that are being provided on the Internet. These applications and services become possible mainly due to higher capacity, varied classes of service, enhanced protocols, added complexity, transition to multimedia technologies, and transition to truly mobile clients and servers. The present and emerging generic applications fall into these major categories (Catlett, 1993):

1. Text file transfer (FTP)
2. Electronic mail (SMTP)
3. Remote login (TELNET)
4. Video teleconferencing
5. Interactive visualization
6. Composite imaging
7. Multimedia mail
8. Character data transfer
9. Multimedia database access
10. Collaboration technology
11. Image transfer
12. Distributed computing

Services that continue to evolve and emerge include providing security, providing directory services, and providing network management. Security services include confidentiality, authentication, integrity, access control, and non-repudiation (Kent, 1993). Directory services provide for users to locate and identify network objects. These directory services include a way for users to find other users on a local host called FINGER, a way to allow for querying a single database on a specified machine called WHOIS, a method of dividing Internet domain networks into distributed sections to ease location of any section quickly and reliably called DNS, a two-step process to locate users by searching databases called NETFIND, X.500 (a single, unified, worldwide system that completely describes all OSI resources), and WAIS (to target coordinated access to information). The final service category is that of network service. The primary network service in the Simple Network Management Protocol (SNMP). SNMP provides for remote management of network resources from anywhere on the network.

b. What Went Right In This Phase

What went right in this phase is a question is still up for debate as the wide spread commercial use of the Internet is so immature. It is clear that the Internet was ready to go commercial. NSF did a service by contracting out the management and access of the Internet to allow for commercial use. Internet

Service Providers (ISP), by accepting NSF money, had to work under the NSF's acceptable use policy that excluded commercial use. This problem disappeared when the NSF money and acceptable use policy disappeared. This commercialization has spawned new business, careers, lifestyles, and way to collaborate. It has also raised questions of free speech, security, and the appropriate use of technology. The impact thus far affects every human endeavor. This should continue but it too early to provide a qualitative assessment.

D. LESSONS LEARNED

1. Open System Approach

Various sources reflecting on the history of the Internet discuss the value of using an open systems approach. In this context, these sources do not merely discuss the limited idea of "open systems" as a hardware and software interoperability issue. Rather, the concept is one of a total system approach using products, processes and people that are open to innovative ideas, methods and products. This concept is more rightly viewed as "open participation" in the process. This far more encompassing concept of an "open system" is much more an attitude than a product, process or protocol.

This approach manifested itself by the true democratic way the people with a common goal were free to suggest ideas and implement solutions. These solutions were briefed to the community and essentially were voted on. The

voting took the form of computer code being run to demonstrate the real world implementation of the idea (Buddenberg, 1997). This democracy resulted from an established method of capturing ideas and disseminating through the establishment of the RFCs. RFCs were not only an historical record but more importantly were a mechanism to quickly get ideas and solutions out in the open for discussion and critical review. This proved essential to the development of the Internet and reinforced the relationships and trust among members of the community.

2. Fielding Plan of Host Computers

An important decision during implementation was the sequencing of which nodes to bring up first on the network. The first node was the host at UCLA. This served as the Network Measurement Center to capture congestion data (Hauben, 1995). Statistics would be run on this data to assist in bringing up future hosts and in Network Management and Control. The other three original hosts each had specific purposes as well. The Stanford Research Institute (SRI) host served as the Network Information Center (NIC), the world's first anonymous FTP server. The University of California Santa Barbara (UCSB) host provided interactive mathematics. The University of Utah provided graphics (Cerf, 1993).

3. Grand Design Versus Operational Network

A third lesson learned was the impact of the decision over the initial design of the network. The network designers "struggled between a grand design and

getting something quickly" (Crocker, 1993c). The initial design has impact not only on how quickly the product is developed but also on what adjustments or upgrades can or should be made later as the network evolved. Although these pioneers tried to think as broadly as possible they ultimately settled for a working network. This led to the problem of scaling that the Internet is facing today. "The somewhat embarrassing thing is that the network address is under pressure now." (Cerf, 1993) Had the initial pioneers thought more grandly or at least developed a plan to scale the Internet from the beginning, the expanding scale of the Internet would not need to be addressed today.

The lesson is to contemplate all potential users of your technology and protocols. Plan for the use of your technology and protocols by the intended users of your network but also develop a plan to scale your network up and out for purposes not initially intended. This suggest to design a network that can be scaled at a later time rather than to build a network that has excessive capacity today. This also serves the purpose of generating broader based acceptance and support of the technology being designed. This prepares for when/if the technology is used for commercial purposes, that the project this technology is initially intended for may benefit by lower unit costs. Risk needs to be analyzed not only for project failure but also for successes beyond ever imagined. The answer to the question "what if everyone in the world has a computer and all are

connected to the Internet at the same time?," would have provided some insight into the scaling question.

4. Request For Comment (RFC)

The fourth lesson learned is to capture a record of all meetings and critical reviews of the project. Although this is a basic concept, it should not be overlooked as it serves multiple purposes.

1. It provides a basis for people in the community that did not participate in meetings or project review sessions to understand what has transpired and in what order decisions have been made.

2. Documentation is typically a weakness of any project.

3. It captures history.

4. If there is any question, at a later date, over intellectual property rights and rights of authorship, RFCs provide a way to clarify those issues.

Ideally, meetings should be recorded by videotape to capture not only words but body language and mannerisms. Written minutes are essential to capture exactly what is discussed. The Network Information Center and the RFC is an ideal vehicle to support this purpose. RFCs were posted on-line at SRI that ran the NIC. RFCs were stored in the world's first anonymous FTP server. This is in contrast to other standards organizations where standards were copy-righted material that are sold for prices to be able to sustain the operations of the standards organization.

5. Management Controls and Guidance

Key to development of the Internet was the management controls and credibility lent to the network developers. ARPA and NSF provided critical guidance at critical moments in the history of the development that brought about success. However, project control was not designed into the development from the start. Instead "Smart management sense [that] paved the way" for the scientists to create the ARPANET. This management sense was provided in the way of people providing comments and influencing the community throughout the project. This author interprets this to mean that there was little consideration for building in life-cycle management from the start in a self-governing manner. The researchers had the benefit of being associated with organizations that had the breadth, skill and pragmatism to interject control at just the right time. This proved very beneficial and should be built into the design of any future network projects.

6. Transition Plan

The final lesson learned is that the ARPANET to Internet project did not have a cohesive acquisition life-cycle project plan. The project evolved with the right people providing fortuitous guidance at just the right time. This loose type of project management process although flexible, did not lend itself to meeting any meaningful cost, schedule, or performance parameters. However, due to the scope of the participants, the varied technology, and the complexity involved in the

Internet project at this point in 1988 when NSF took over, maybe the best that could have been expected of NSF was to provide the coherence to all project participants so development could flourish at the expense of what looks to be a poorly controlled project (Buddenberg, 1997).

III. OVERVIEW OF THE SEANET PROPOSAL

A. SEANET PROJECT BACKGROUND

1. Purpose

The purpose of this project is "to provide transparent connectivity for ships in the oceanographic research fleet routinely." The oceanographic research fleet personnel use the Internet and WWW on land for their research and they want to be able to use it when underway at sea. They can communicate while underway but each vessel cannot share data very well with the other research vessels or with land-based sites due to system incompatibilities.

> Currently deployed data communications limit the task of best supporting oceanographic research today. Although data communication to and from ships is common, each ship has its own way to send email, transfer files, or perhaps provide interactive services. The communications cost for these services are high and users often experience low throughput and a variety of communications systems problems. (Kappel, 1997)

Technical support at sea is spread thin. Typically, each remote unit will have one technician that has to keep all the oceanographic equipment operational along with being the network manager. Remote network management is not in the system at this time (Buddenberg, 1997).

2. Project Participants and Roles

a. Introduction

This section describes those organizations that are involved in the SEANET project and the roles that each organization plays. The participants are organized into two levels of participation: primary and supporting. The primary participants generally have a specific role or function, are required to provide a deliverable product, and they have an interest in the Oceanographic Fleet. The supporting participants provide limited products and services and generally do not have an interest in the Oceanographic Fleet other than through providing computer communications to the fleet.

b. Primary Participants

This material is a recap of the Seanet proposal submitted to the Office of Naval Research (ONR) in 1997 to develop a capability for the oceanographic research fleet.

Joint Oceanographic Institute (JOI) provides liaison and are a primary SEANET project coordinator. They interact with federal agencies and the science community. The also coordinate with the Advisory Panel.

Woods Hole Oceanographic Institute (WHOI) shares duties as a primary SEANET project coordinator and is the responsible agent for the Shipboard Communications Node (SCN) development.

Lamont-Doherty Earth Observatory (LDEO) is the responsible agent for INMARSAT-B procurement. They are also responsible for shipboard system installation and testing.

OMNET, Inc. is the responsible agent for the SEANET Operations Center. They are also responsible for billing and use accounting of the SEANET network. They also provide value added services as necessary.

Naval Postgraduate School (NPS) is the responsible agent for the Shipboard Implementation Laboratory. They monitor emerging technology. They also act as the liaison agent with the US Naval Research and Development Center (NRaD).

Individuals from these organizations recognized an internet extension would be a significant enhancement to the oceanographic research fleet mission but budgetary sponsors did not until 1997. Sponsorship in the form of money and commitment occurred in 1996 that funded research and development in 1996. (Buddenberg, 1997)

c. *Supporting Participants*

The following groups and organizations provide services and products that the SEANET primary participants are leveraging to achieve their project goals. These supporting participants are as follows:

COMSAT is a satellite communications vendor. They will provide reduced rates for access to their satellite communications channels. They provide engineering support and potentially enhanced services as satellite technology improves.

MAGNAPhone provides 20% hardware discounts. They will assist with engineering support and they benefit by having key input into their product design from the SEANET prototypes.

MCI, Inc. will provide free circuits and act as the SEANET project's terrestrial Internet Service Provider.

The US Naval Research and Development Division (NRaD) is a component of the NCCOSC. They will provide technological transfer of military unique solutions that have application to non-military users will underway at sea.

NAVOCEANO is an organization involved in oceanographic research that is interested in lending support to the SEANET project for transfer back into the military once proof of principle occurs. They are peers to university oceanographic research personnel.

3. Project Strategy

Seanet participants want to replicate what NSF did with the regional ISP, start a commercial industry, but in remote regions. They want to provide at-sea internet service the way terrestrial service is provided today.

4. Project Objectives

The SEANET project has six primary objectives.

a. Provide Communication Channels

The project is interested in integrating ships underway with land based stations using various radio links. Those presently known are INMARSAT-B Channel at 64kbps, cellular telephone at 9.6kbps, AMSC satellite channels at 4kbps, and High Frequency radio channels at 2.4kbps.

b. Provide Reasonable Data-Communication Rates

The project aims to provide incentives for oceanographic research fleet users to utilize the SEANET network for their research. This is not only to increase the community of users so that there is acceptance of the technology but also to generate the market forces that will result in lower rates unsupported by subsidies. This is an issue of economy of scale. The oceanographic research fleet benefits by pooling its own resources. Furthermore, if a generic capability is developed that is useful to other users beside the research fleet, the research fleet can benefit by buying services at marginal costs.

c. Provide Network Operation

Essentially, this entails providing the functions of an Internet Service Provider (ISP) dedicated to the SEANET project. These functions include point of presence for all wireless channels, firewalls to limit access into the SEANET for

only authorized users, network management, standard terrestrial ISP services, and maintaining a shore-base SCN. This support is a form of venture capital that assists in growing an industry.

d. Provide Network Information Services

These services include shipboard installation support, 24 hour customer services for ships underway, business services for billing and accounting for carrier use, and web page development, maintenance and distribution. These services are another form of venture capital.

e. Integrate Internet Over HF Radio

Tailor technology already developed by the US Navy through technology transfer to integrate Ship-based and Shore-based stations in the SEANET network.

f. Establish SEANET Testing and Technology Laboratory

The Naval Postgraduate School provides graduate education to members of the Department of Defense that have a professional interest in mobile platform communication. Therefore, NPS has the space, testing equipment, and personnel that naturally provide value to the project through testing of new techniques and technology. Testing can involve new technologies such as new communications channels, remote network management, and equipment upgrades.

5. Objective Limitations

There are three key limitations to achieving these objectives as the project is currently scoped. They involve infrastructure, protocols, and a business model. The following are infrastructure limitations.

1. AMSC links suffers from propagation delays that severely degrades performance of highly interactive applications. This link is functional but only for coverage in North America and to 100 miles off-shore. It is only narrow-band voice capable at this time.

2. The INMARSAT-B link also suffers from propagation delays but offers global coverage except at high latitudes.

3. High-Frequency (HF) offers global coverage but atmospheric conditions can result in coverage being blocked out at specific ship or shore locations.

4. The cellular technology requires a grid of receivers in close proximity to the moving ships. There is not a cellular grid at sea or in remote areas like the terrestrial cellular grid in built up areas to pass signals to the ground or satellite system.

5. All these links are all circuit-switched point to point voice telephone type systems versus packet-switched IP type systems. Therefore, adjustments must be made.

The protocol limitations assume ethernet-like connectivity. Ethernet uses three way handshakes that do not fit the intermittent service and batch orientation of radio links nor does it fit into the telephone system channels. None of the links above provide a presence all the time like a wireline ethernet system.

There are three business model limitations. The connectivity providers need to move from the packet-switched mentality from the circuit-switched mind-set. A community of users must be nurtured to demand the capability and this can only done with incentives to pursue Seanet goals. Commercial ISP must be convinced through the prospect of profits and technical capability that the Seanet goals are feasible.

6. Project Organization

This project is organized as a collaboration. Two of the primary participants (Maffei and Heinmiller) felt the project would be "more successful if there was a community wide consortium." The project participants have different skill and traits that lend themselves to an Integrated Product Team (IPT) approach. The project group seeks "all parties interested in pursuing the goals [of the project] ...in a consensus style. The project group realizes that planning is critical to a successful IPT approach but project coordination is vitally important. The project group assigned responsibility for technical control to Mr. Maffei and community coordination to Dr. Ellen Kappel.

B. NETWORK DESCRIPTION

This section will describe the SEANET network. It consists of shore-based systems, ship-based systems, and the communication channels that provide connectivity between ship and shore.

1. Shore-Based System

This portion of the network provides the interface between the SEANET and the traditional Internet. This is achieved by a Network Operations Center (NOC) run by MCI that uses a router and the SEANET Wide Area Network to connect to the Internet. OMNET will run the Network Information Center (NIC) services using their own host computers connected to the NOC. OMNET also has the accounting and billing responsibilities to ensure that users are being charged accurately based on established rates. A frame-relay network will connect to the hosts that transfer to the Up-link/Down-link points depending on the type of communications channel the users chooses or is forced to use to access the Shore-based systems. The following diagram (Figure 1) provides that graphic for the functions that occur on land and the points that transmit to and from the ships underway.

2. Ship-Based System

Figure 2 shows the ship-based system include all the hardware and software that necessary to best optimize the connections from the ships underway through the various communications channels available. Each research vessel will possibly have multiple researchers working different projects from nodes connected to the shipboard Local Area Network (LAN). The SEANET Communication Node (SCN) will be the front-end tool to optimize connections between the various

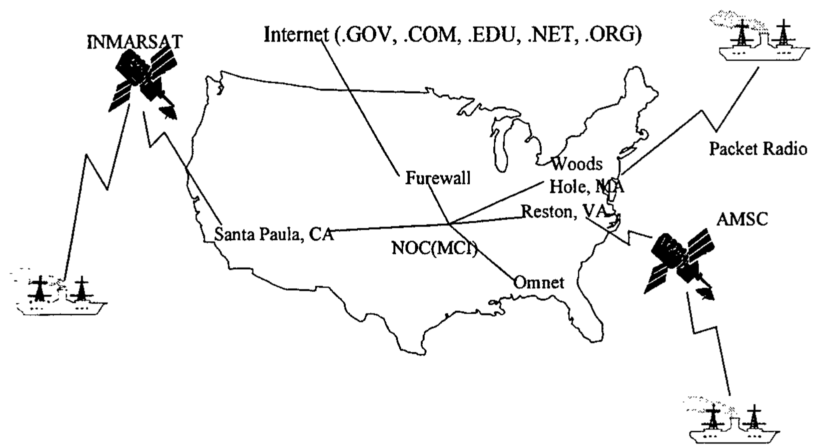

Figure 1. Shore-Based System

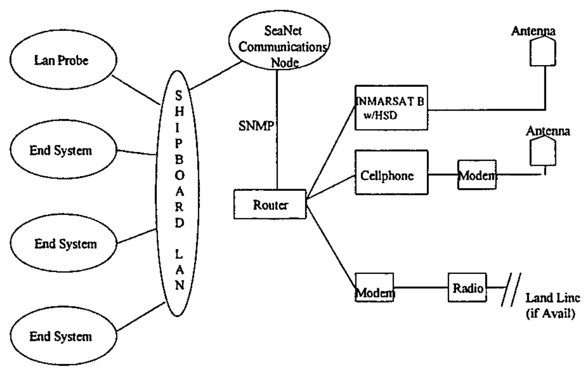

Figure 2. Ship-Based System

nodes on the ship's LAN with the various communication channels available to transmit and receive from shore-based stations.

IV. APPLYING LESSONS LEARNED TO SEANET

A. STRATEGIC APPROACHES APPLIED TO SEANET

1. Introduction

This section analyzes the SEANET approach to achieving its stated goals in terms of the strategic approach the Internet used. This section will analyze in terms of the spirit of the SEANET expansion, the standards of the SEANET expansion, and the organization and management style of SEANET.

2. The Spirit of the Seanet Expansion

The overall spirit of the SEANET is very similar to the Internet Evolution but towards different ends. The Internet initially was geared toward pure research. The SEANET project has been focused on providing a product to achieve the set purpose of supporting Oceanographic Research. This project is not as concerned with research in communications purely for research sake. However, the SEANET project is very similar to the Internet expansion in how it approaches the task. The SEANET project follows a collaborative approach making itself available to leveraging the talents and resources of those with interest in supporting Oceanographic research. The collaborative spirit proved essential to the Internet and likewise should prove to be a critical way for the SEANET project to be successful.

3. The Standards of the SEANET Expansion

SEANET is building a computer communication network for the Oceanographic Research Fleet. They accept participation of those organizations and individuals with interests in the Oceanographic community. It is important to get the user involved in defining requirements so that the right product is built for the right reasons. It is equally important to have the right people build the product. The Internet evolution set as a standard to use "the best academic computing centers" to design and build the Internet. This author has not seen a similar stated standard espoused by the SEANET project. This is not to suggest that the organization and personnel participating in the SEANET project are not capable or competent in their respective areas of expertise. This issue is that unlike the Internet evolution, the SEANET project is not using the "best academic communication centers" to design, develop, and build their networks. The question is does the SEANET project participants have the past performance and reputation that matches the Internet collaborators in the area of computer communication? The SEANET project should consider soliciting participation from a larger circle of academic and commercial research center conducting wireless networking research. The credibility gained and academic support might prove useful.

4. SEANET Organization and Management Style

The final strategic area to analyze involves the organization and management style of the SEANET project. The Internet project like the SEANET project uses a collaborative style. Internet received critical guidance at critical points in time necessary to evolve the Internet. The issue is will SEANET be as fortunate to receive the same "smart management sense" at critical points in time to have an equally or more successful network development. The SEANET Advisory Panel should provide a role towards providing management guidance as the project progresses. The issue is why not develop a flexible management plan and flexible project controls from the start that supports the development. This project is in the Program Definition and Risk Reduction (PDRR) Phase of its life-cycle and such a management and project control plan integrated into the system design should prove beneficial in keeping cost, schedule, and performance goals on target.

B. LESSONS LEARNED OF INTERNET APPLIED TO SEANET

1. Open Systems Approach

This section analyzes the SEANET project's Open Systems Approach. This approach proved invaluable to the Internet development when coupled with utilization of the best academic computing centers. The SEANET project proposal

states and appears to actively solicit the participation of any organization or individual with an interest in oceanographic research. The critical aspect of this project, the communication system being produced, provides a function that any group not just the oceanographic research fleet could utilize. Therefore, SEANET should seek the participation and actively solicit any organization or individual with an interest and proven background in wireless computing. The project participants have been seeking this participation but it is the opinion of this author that the project participants have not developed a formal marketing plan with someone whose sole responsibility is to market the project and solicit development participants. This expansion of participation could be manifested by other long haul communication companies, other satellite companies, and other technologies. The list could include AT&T, GTE, Orbcomm, Teledesic, Globalstar, TRWs Odyssey as well as other academic computer communications researchers. This expansion should include the many different emerging technologies like Low Earth Orbiting (LEO) Satellites during the design phase. This would allow these technologies to be easily and more inexpensively incorporated as a planned product improvement when these technologies mature. Creating modules for emerging technologies in the SEANET Communications Node that are inactive until those technologies mature will provide the SEANET project greater flexibility to adapt and greatly improve throughput at a later time while

minimizing the cost of redesigning the system after it has been built. Inclusion of emerging technologies of LEOs during the design phases would provide an easier transition to those mediums once the technologies become operational in the out-years beyond the funding period of this project. Greater participation of companies with capabilities already represented in the project should promote competition that might translate in lower rates to users and would ensure that there are second sources for products and services should the sole source be unable to deliver.

2. The Plan For Fielding

The next lesson learned from the Internet development involved the fielding plan of the nodes on the network. The initial host computers of ARPANET were brought up on the network in a specific order for well-intentioned reasons. The SEANET project is a prototype with a well diagrammed network topology. The fielding plan for the prototype system is not a significant issue since the entire land-based infrastructure portion of the system must be in place prior to the ship-based infrastructure can connect through the SEANET to the Internet. The land-based and ship-based portions can be installed simultaneously but not connected. The SCN controls the integration of both the land and ship based segments of the network. The issue of the order of activation of the nodes is not as critical as its was for the initial host computers on the ARPANET.

3. Grand Design vs. Operational Network

This section analyzes the decision of building a network with a grand design or a network that is operational. The SEANET proposal established as a goal to integrate using common software, hardware, and protocols. Therefore, the SEANET proposal seeks an operational network. This foregoes an opportunity to design, build, and operate a network having greater appeal to a larger community than the Oceanographic Research Fleet. Greater appeal developed from a network with a larger scope or grander design would have the benefit of attracting more users to the network. If well managed and scaled, a larger network should reduce the unit costs to users and might provide even greater research resources from organizations presently participating in the SEANET project.

4. Documentation

This section analyzes the documentation and critical external reviews that the SEANET project is subjecting itself. SEANET has proposed establishing an on-line repository for project documentation. They also will undergo periodic review from an advisory panel to generate constructive feedback involving all aspects of their system development. At this early stage of the project, what cannot be answered is how the project participants will incorporate constructive feedback into design reviews. This suggests a need for configuration control especially since new technologies later developed might result in product

improvements subsequent to completion and fielding of the network. It is more costly to make changes to a product the later those changes are incorporated in the life-cycle of the product. SEANET should not only capture and incorporate approved changes quickly but do as thorough a job as possible in planning the easiest and cheapest way to incorporate the changes.

5. Management Controls

This section analyzes the management controls. This is the area that is most critical to ensuring the project meets cost, schedule, and performance goals. The project has identified a project schedule. The project schedule already must be readjusted due to delays in funding. However, there does not appear to be any controls established to monitor cost and schedule and to sample performance. Monitoring expected cost and schedules versus actual cost and schedule would provide statistical ways to understand the implications of changes in cost and schedule. The concept of Earned Value would provide the project a way to understand how changes in cost and schedule impacts performance. These controls established early would support the project participant's ability to objectively determine the trade-offs to make based on user requirements.

6. Incentives

A technique DARPA used to speed the implementation of infrastructure was to hold a demonstration of the capabilities that the ARPANET could provide.

DARPA set a date in advance to spur those individuals working on the ARPANET to speed development. It was a way to use the human nature of the participants against themselves. It established a mark on the wall to jump over. This expectation to perform and not let the community of users down motivated the participants to work towards a goal, finish those aspects of the project that were not complete and make enhancements to benefit the project. This technique would be a useful tool for the SEANET participants. A demonstration of the SEANET capabilities at a renowned conference would serve to not only provide an incentive to spur development but what also be a way for the SEANET project to advertise their capabilities. This announcement of capabilities could generate support behind that already achieved to increase the user base and could result in attracting other functions and skill sets the project participants might lack to make the project overwhelmingly successful.

C. CONCLUSION

This chapter analyzed the SEANET project in terms of its Strategic approach and in terms of the lessons learned from the Internet development. The SEANET project is off to a good start based on its stated objectives. The have incorporated some of the same strategic approaches that the Internet used during development and have benefited from its lessons learned as well. There are differences as well that the SEANET project has not incorporated and would be

advised to do so. The primary approach that would be wise to enhance is in the area of soliciting the assistance of more organizations and personnel with a proven reputation in wireless computer communications. The primary lesson learned involves developing management controls early in the life-cycle to assist meeting cost, schedule, and performance measures. The next two chapters will provide insight into why a project management plan would be useful and how to develop a project management plan that establishes management controls to enhance the effectiveness of the SEANET project.

The question raised is what should happen next, how should it be accomplished, and why should these steps be taken. The design reviews by the project collaborators that are occurring in the early fall of 1997 using IPT approach is a natural way to integrate and develop the detailed plans that provide the direction to the project. These design reviews are a perfect opportunity to take an inventory of the skills and functions that the project has at this point in its development, determine deficiencies across all areas of the development that includes project policy, system engineering, software management, test and evaluation, manufacturing and production, logistics, cost estimation, financial and contract management, and develop techniques to meet these deficiencies. The project chose to act in a collaborative fashion. As a result, each project participant is responsible for being involved in the pain-staking process of developing the

inventory, designing solution or determining the skills that must be present to overcome skill and function deficiencies. An experienced project manager would help provide the business and management focus. The project appears to have the technical areas covered but there appears to be some integration and planning assistance needed. This is a critical point in the project because what develops out of the design reviews will be what the project builds. The design reviews can be a catalyst for coordinating and integrating the project or it can be an opportunity to participants to focus on a narrow scope of issues that are important today but forego the opportunity to develop long and short range plans that meet the projects ultimate goal of providing remote access to users in a cost efficient manner.

V. PROJECT MANAGEMENT PLAN (PMP)

A. INTRODUCTION

This project beckons for an overarching Project Management Plan (PMP). A cohesive life-cycle management plan was a weakness in the development of the Internet. It should be addressed by the SEANET project to improve the effectiveness of the project and speed development. This plan would leverage the lessons learned from the ARPANET to Internet expansion. It would tailor life-cycle management plans that have proved effective in delivering projects that meet cost, schedule or performance goals. The SEANET project recently received funding to pursue its goals. The SEANET project will begin a series of design reviews to finalize roles, responsibilities, and establish cost, schedule, and performance measures. A detailed project plan would prove useful to more effectively enable the participants to meet their goals. This chapter will discuss the rational for establishing such a plan that would make the SEANET project more effective and timely. This chapter will discuss the purpose for a PMP and the general procedures to follow.

B. PURPOSE

1. Background of the PMP

The SEANET PMP provides the direction and strategy for the SEANET program. While the PMP should be done for all programs, experience shows that it is particularly important for projects that integrate many communities that find themselves with common goals. If the PMP is done properly, much of the information contained in it can be summarized to form the System Development Plan (SDP). The PM is responsible for completing the planning activity in support of the program.

2. Purpose of the PMP

The purpose of the PMP is to:

1. Provide the SEANET program strategy and plans of action for attaining program objectives.

2. Identify responsibilities all staff, partner & support organizations, customers, and contractors who will work on the program.

3. Define the resources required to execute the program.

4. Provide a master schedule of tasks and program milestones.

3. Project Manager's Responsibility

The PM serves as the integrating force throughout the program, and it is the PM's responsibility to develop and maintain the PMP with functional and technical support. The PMP should be consistent with the program baseline used to manage

program performance requirements, cost and schedule throughout the program. The SEANET project has various individuals whose roles is to coordinate specific aspects of the project. It does not appear due to the collaborative nature of the SEANET project that any one person is acting in the role of Project Manager whose sole purpose is to maintain an overarching management perspective in meeting cost, schedule or performance objectives. This authors suggests that the project members should establish this role and develop a project management plan (PMP). The following is a recommended PMP. The SEANET PMP should accomplish the following:

1. Organize and staff the program.
2. Support effective communication of program information.
3. Establish budgetary and time estimates for overall program and major work elements.
4. Establish a common core set of management metrics from which to evaluate and control software development.
5. Manage performance, cost, and schedule risks.
6. Provide a quantitative framework from which progress can be assessed, variances can be calculated and analyzed, and alternative courses of preventive or corrective action can be evaluated.

C. PROCEDURES

The PMP should be designed to facilitate program coordination, communication, planning, and control rather than provide technical direction to participants. Therefore, it should only developed to the level of detail necessary to apportion the work among the functional activities within the SEANET community and other parties involved in the program. The following paragraphs are key considerations for successful development and execution of a PMP:

1. Migration Strategy

The PMP should support the selected migration strategy. Migration system/application selection should be based on the following factors:

a. **Functional:** To be selected as a migration system/ application, the information system will have to be based on defined work processes and will have to be based on the degree to which the system meets the information needs of users within and across functional areas. A decision should be generally supported by the functional user community representing project stakeholders.

b. **Technical:** The system/application can evolve (migrate) to be supported by the DoD Technical Architecture Framework for Information Management (TAFIM). Each of these systems/applications must be integrated

into the Defense Information Infrastructure (DII) Common Operating Environment (COE) and Common Data Environment (CoDE).

c. **Programmatic:** Office of Naval Research will undoubtedly require a functional economic analysis that documents a reasonable range of alternatives that meet both functional and technical objectives. The alternatives must be within programmatic constraints (resources, schedules, and acquisition strategy), and justify adopting the migration system/application for the community. The migration system/application selection can be based on an abbreviated functional economic analysis.

d. **Data:** The ability to transition to data standards is a fundamental requirement for an information system in order for it to be selected as a migration system. Applications should lend themselves to data sharing within their design. Migration plans must include transition to commercial industry standard data and shared data concepts.

2. Project Strategy

The PMP should support the program strategy that will be used to design, develop and deploy the SEANET project, e.g., grand design, incremental, evolutionary or other. In selecting the appropriate strategy, the unique circumstances of individual programs should be considered and the strategy chosen must remain consistent with the project's acquisition policy.

a. In determining which activities apply to each increment, the key question to be answered is: what are the objectives of the increment? From this point, more detailed planning would be required. Define each system increment in terms of the requirements it will meet and its composite hardware, software, and data base components. To be useful, an increment should conform to the following rules:

(1) Satisfy a subset of the requirements to be met by the complete system.

(2) Constitute an entity that can be used to demonstrate to the customer that a functional subset of the requirements has been met.

(3) Represent a logical division of the design of one or more increments or builds.

(4) Provide a solid core for meeting the requirements assigned to the remaining builds.

b. Successful execution of an incremental or evolutionary program strategy requires a number of changes to relationships and practices common to more conventional or "grand design" programs:

(1) The need for a closer, interactive set of relationships among the functional user, the developer, the independent evaluator, and the supporter.

(2) The need for streamlined procedures to allow each increment of capability to progress rapidly through definition, design, development, testing, fielding, operational evaluation and integration into the operational environment.

3. Software Metrics

Software metrics provide a quantitative framework from which to evaluate and control software development or integration and may be divided into three general categories: management, requirements, and quality.

a. Management metrics are measures that help determine progress against the plan. Trends in management metrics support forecasts of future progress, early trouble detection, and realism in plan adjustments.

b. Requirements metrics pertain to specification, translation, and volatility of requirements.

c. Quality metrics deal with testing and other software technical characteristics.

A common core set of management metrics for software should be developed early in the development cycle.

VI. PROJECT MANAGEMENT PLAN FORMAT

A. INTRODUCTION

This chapter provides the SEANET Project participants with a format to develop a plan to provide management control over their activities. This will assist the project members in meeting cost, schedule, and performance objectives. This should prove helpful to the project as they recently received funding to pursue their objectives in establishing connectivity for mobile platforms (research vessels underway at sea) with the terrestrial Internet.

B. SEANET PROJECT MANAGEMENT PLAN FORMAT

1. Purpose

State the purpose of the Seanet Project Management Plan (PMP).

2. Objectives, Scope, and Major Activities

A brief description and statement of purpose of the SEANET Project being developed or acquired. Reference SEANET Mission Need Statement.

3. Organizational Responsibilities and Relationships

Identify the management team/staff, acquisition agent, other support organization elements and contracts that support the effort. Reference the SEANET Project Manager's Charter.

4. Management Approach

Summarize all major tasks to be performed, program management structure, approach, stakeholders, schedule, and required resources.

5. Migration Strategy

Summarize factors for selection:

1. Indicate how the proposed system will support the "to be" work processes and the degree to which it meets the information needs of users within and across functional areas.

2. Indicate how the implementation/deployment of the proposed system will ensure compatibility with components of by the Information Infrastructure and the Operating Environment.

3. Summarize alternatives that meet both functional and technical objectives, and are within programmatic constraints (resources, schedules, and acquisition strategy). Justify adopting the selected migration system.

4. Indicate the ability to transition to data standards, and show how applications lend themselves to data sharing within their design.

6. Acquisition Strategy for Migration Systems

Summarize acquisition considerations for selection:

1. Indicate how existing Information Systems, peripherals or other assets in place will be used to support the proposed migration system.

2. Describe existing indefinite delivery and indefinite quantity (IDIQ) or other contracts that will be used/considered to satisfy requirements that cannot be met through existing assets.

3. Identify existing contracts for the system, when awarded, and any issues involving awards.

4. Identify any potential acquisition issues.

5. Describe the level of proprietary technology and related impacts to the SEANET project.

6. Indicate whether existing contracts contain language requiring the use of data standards and the use of Enterprise Data Model structures.

7. Defense Information Infrastructure

Describe how the proposed system will support the level of integration required. Indicate how the proposed system will evolve to be supported by the integrated, standards-based architecture prescribed for. This is important since the oceanographic fleet might need to communicate and integrate with defense or government agencies such as the U.S. Coast Guard that also use standards-based architectures.

8. Program Strategy

Present the appropriate program strategy that will be used to design, develop, and deploy the Information System. A discussion of the grand design, incremental, evolutionary and other program strategies is contained in this DOD Acquisition Deskbook (Defense Acquisition Deskbook, 1997).

9. Data Standards

Indicate the ability to implement standard data structures (models as well as data standards), and how applications lend themselves to data sharing within their

design. The following are sample considerations for determining data migration and standardization feasibility.

1. Indicate if and how data are separated from applications (e.g., use of APIs, DBMSs).

2. Indicate the extent to which the Information System is modeled (logical and physical). If both logical and physical models exist, indicate whether they are mapped to each other and in what tool.

3. Indicate whether the migration system logical data model is mapped to the SEANET Enterprise Data Model and the extent to which the migration Information System uses standard data and implements Enterprise models.

4. Indicate to what extent the data elements (standard and non-standard) are registered in a Data Repository (DR), and, if applicable, whether the system is registered as a user of the standard data elements in the DR. For Information System using non-standard data elements and structures, indicate whether a data migration strategy exists and, if so, is documented and approved in a Project or Functional Data Administration Strategic Plan (DASP) Action Plan(s) (if so, attach appropriate extracts from the DASP).

5. Indicate the extent to which data are shared with other applications both received from as well as provided to other applications). Where data is shared with other applications, indicate whether documented translations exist and where they are recorded (e.g., repository, system code, etc.).

10. Metrics

Identify a common core set of management metrics, considering key measures such as:

1. Schedule and Progress - regarding completion of program milestones, significant events, and individual work items.

2. Growth and Stability - regarding stability of required functionality or capability and the volume of software delivered to provide required capability.

3. Funding and Personnel Resources - regarding the balance between work to be performed and resources assigned and used.

4. Product Quality - regarding the ability of delivered product to support the user's need without failure, and problems and errors discovered during testing that result in the need for rework.

5. Software Development Performance - regarding the developer's productivity capabilities relative to program needs.

6. Technical Adequacy - regarding software reuse and use of approved standard data elements.

11. Schedule

Provide time schedules for accomplishing tasks.

12. Resource Requirements

Identify resources required to support the development effort.

1. **Manpower**. Summarize target and projected manpower requirements.

2. **Funding**. Summarize target and projected funding requirements.

13. Risk Management

Identify any special needs or characteristics that could represent areas of risk. For example, identify any needs for new technology development, and schedule dependencies external to the program's control, and any special skills required to perform the work.

1. Identify any risks that may have a potential impact on program performance, cost and schedule.

2. Prepare a profile for each risk including: probability, cost impact, schedule impact, earliest expected visible symptom, and action plan(s) to be invoked upon detection.

3. Update and monitor risk plans to account for new potential and manifest risks.

C. CONCLUSION

The establishment of a Project Management Plan (PMP) is critical to ensuring that the project can meet its baseline goals. Without such a plan there will be no control measurement to objectively determine when or if the project is meeting cost, schedule, or performance goals. Furthermore, a PMP can alert project members quickly when critical aspects of the project create a risk that impacts the entire project. Management controls enable the project members the opportunity to make informed judgments in reducing risk and making adjustments to ensure the project goals are met as originally planned. The SEANET Project is currently organized as a collaborative effort. Therefore, a SEANET PMP should be developed and agreed upon by all participants to ensure success. There is no value in developing a plan that will not be followed. The SEANET project is at a point in the life-cycle that provides for a natural way for such a plan to be developed and for someone with credibility and authority to be designated as the proponent of that plan. The SEANET project already has had to adjust their

schedule due to external funding delays. This is a very reactive position to be in. A PMP would assist in identifying project problems so the project participants can take corrective action quickly to ensure the project is kept on track.

VII. SUMMARY

A. THESIS SUMMARY

The Internet has transformed and continues to transform every human endeavor. Commercialization of the Internet is largely responsible for this phenomena. The Internet had proved to be a case of how a limited purpose technology evolves into a technology with global impact. This occurred by government funding and nurturing research and development and transferring that technology into the commercial sector. The market based commercial sector through competition proves to increase efficiency, improves quality, and provides goods and services at attractive prices.

There are still many areas of the Internet that require improvement and enhancements to meet and exceed user's requirements. One area is involves the concept of "ubiquitous computing and communication." Many areas of the globe do not have access to the wired Internet due to their physical location on the globe or due to lack of infrastructure that to support Internet access. Generally, these areas are at sea away from the coastlines of developed countries, on land in remote or undeveloped areas, or in space. People everywhere are beginning to expect to have Internet access wherever and whenever they are.

The SEANET Project is an attempt to provide Internet access to remote users not connected to the wired Internet. It took the wired Internet 26 years to become mature enough and cost efficient enough to transition to the commercial Internet. Once the Internet went commercial the uses, applications, and demand for access has increased at amazing rates. Unlike the developers of the Internet, the SEANET project does not have the luxury of 26 years to mature and evolve their technology. Users now have higher expectations of using the Internet when and where they want.

This research explored how the SEANET project can more effectively expand availability of remote access to the Internet to meet users demands. It did so by using the evolution and transition of the ARPANET from a military project for command and control of strategic nuclear forces to the present day Internet to understand lessons learned that should apply to the SEANET project. This research also described a way for the SEANET project to better achieve its goals through the adoption and implementation of a project management plan. The SEANET Project is still in the early stages of designing its system. A comprehensive plan should better define project participants roles, should foster better communication and an understanding among all participants of what and why they are building this network, and it should provide the framework for the project to better adapt to changing requirements. Using an IPT approach to

develop the plan, a set of management controls and milestones should ensure the project meets its objectives. Should the project participants determine they are not meeting their objectives, they can more quickly adjust their scope. The PMP developed can act as a framework that the project participants use throughout the project life-cycle to plan execute, control and adjust their activities.

B. RECOMMENDATIONS

There are four major recommendations that resulted from this author's research. These recommendations are taken from their successful use in other projects as reflected in the lessons learned from the Internet evolution or from practices utilized in both government and/or commercial project management disciplines. The recommendations provide a way to enhance the effectiveness of developing a wire-less capability. The following provides a way to organize these recommendations.

1. Use the Lessons Learned that Apply to SEANET

- Continue to use the IPT approach and actively seek the participation in and feedback from all stakeholders.
- Develop a fielding plan.
- Develop an operational network but maintain a grand design or architecture based outlook.
- Enable access to project documentation.
- Develop management controls.

2. Develop a Strategic Vision

- Provide an understanding of what the project wants as a result that captures the emotions of project participants and possible users.
- Create an environment that attracts quality people and organizations
- Review and update the management style and organization so the appropriate approach is used through the entire project life-cycle

3. Implement a Project Management Plan

- Assign a project manager with proven experience and credibility.
- Develop a formal PMP during the upcoming design reviews utilizing the framework provided.
- Develop clear roles and expectations for each project participants.
- Develop a migration strategy early that transitions project through different project life cycle phases.
- Establish a statistical control plan for cost, schedule, and performance goals.
- Develop consequences for not meeting cost, schedule and performance goals.

4. Develop a Marketing Plan

- Assign responsibilities to market the project to attract people, ideas and funding.
- Conduct a demonstration at an internationally recognized computer communications symposium to motivate participants to achieve a certain capability by a certain time and to generate broad interest in the project.

The SEANET project has immense possibilities to impact all human endeavors to an even greater extent than the Internet. There are opportunities to enhance the effectiveness of the project with a more structured approach to the planning and control of the project.

C. FURTHER RESEARCH

The SEANET project is seeking to solve a problem for the oceanographic research fleet. However, the solution has benefit to many different user both commercial, governmental, and private. There are many areas and disciplines that can be explored to benefit this project and to link application to other human endeavors.

1. What organizational staffing considerations are there that would enhance the SEANET Project?

2. What considerations should there be made to test and evaluate the project through the entire project life-cycle?

3. What logistical support considerations need to made to implement and support the project?

4. What are the implications to the project regarding manufacturing and production planning?

5. What contract types by phase enhance the project as it evolves and transitions to the commercial sector?

APPENDIX. ACRONYMS AND ABBREVIATIONS

ANS	Advanced Network Systems
ARPA	Advanced Research Projects Agency
BITNET	Because It's Time Network
CoDE	Common Data Environment
COE	Common Operating Environment
CREN	Computer Research Engineering Network
CSNET	Computer Science Network
DARPA	Defense Advanced Research Projects Agency
DII	Defense Information Infrastructure
DNS	Domain Main Server
DOD	Department of Defense
EV	Earned Value
FTP	File Transfer Protocol
IBM	International Business Machines
ICCC	International Conference on Computing Communication
IDIQ	Indefinite Delivery and Indefinite Quantity
IMP	Integrated Message Processor
INWG	International Network Working Group
IPT	Integrated Process Team
IPTO	Information Processing Techniques Office
IPv6	Internet Protocol version 6
ISP	Internet Service Provider
JOI	Joint Oceanographic Institute
LAN	Local Area Network
LDEO	Lamont-Doherty Earth Observatory
LEO	Low Earth Orbital

NCP	Network Control Protocol
NIC	Network Information Center
NOC	Network Operations Center
NPS	Naval Postgraduate School
NRaD	Naval Research and Development
NREN	National Research and Education Network
NSF	National Science Foundation
OSI	Open System Interconnection
PDRR	Program Definition and Risk Reduction
PM	Project or Product Manager
PMP	Project or Product Management Plan
RFC	Request For Comments
RFP	Request For Proposal
SCN	Shipboard Communications Node
SDP	System Development Plan
SMTP	Simple Mail Tool Protocol
SNMP	Simple Network Management Protocol
SRI	Stanford Research Institute
TAFIM	Technical Architecture Framework for Information Management
TCP/IP	Transmission Control Protocol / Internet Protocol
T1	a dedicated line that can carry 1.544 megabits per second
T3	a dedicated line that can carry 44.736 megabits per second
UCLA	University of California at Los Angeles
UCSB	University of California at Santa Barbara
WAIS	Wide Area Information Services
WHOI	Woods Hole Oceanographic Institute
WWW	World Wide Web

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